Identification of Bankfull Stage

Vermont Stream Geomorphic Assessment

Vermont Agency of Natural Resources
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Use of Bankfull to Delineate the Channel

Consistent measurement of river dimensions, that are comparable between sites and over time, first requires a method for consistently delineating river channel limits. Because the flow level may change from day to day or minute to minute, the river cannot be defined as the wetted area at the time of assessment.

Instead of using wetted area at a given time to define the river it is more appropriate to define the size of the river based upon the channel. The channel limits can be defined by the bankfull stage: or the point at which the flow just begins to enter the active floodplain (Leopold, 1994). Use of the bankfull stage is beneficial because it has hydrologic and morphologic significance which render it a consistent benchmark for comparison between sites that is identifiable in the field.

Hydrological Significance of Bankfull: Flow measurements conducted on gaged rivers around the world show that the bankfull stage has a recurrence interval of 1.5 years on average. This means that in any given year there is a 67% chance that the river will rise to or overtop the active floodplain. Because the bankfull flow equates to approximately the 1.5 year flow, on many rivers we can use the bankfull stage as a benchmark from which to measure channel size for a consistent comparison between sites.

Morphological Significance of Bankfull: Long term bed load and flow measurements have shown that it is the bankfull flow that transports the greatest amount of material over time (Leopold, 1994). While larger flow events transport greater quantities per event and smaller flow events occur more frequently, it is the bankfull flow that is sufficiently effective and sufficiently frequent to perform the greatest amount of work in maintaining channel shape and is thus also referred to as the “effective discharge” or “channel forming flow.” Because the bankfull flow does the greatest amount of work informing the channel, the bankfull stage is identifiable in the field.

The Active Floodplain: A channel is said to be at bankfull stage when it is just about to flood the active floodplain. Thus the active floodplain defines the limits of the bankfull channel. The active floodplain is defined as the flat portion of the valley adjacent to the channel that is constructed by the present river in the present climate (Leopold, 1994). The phrase “by the present river in the present climate” is especially important because if the river degrades or incises, what was formerly the floodplain is abandoned and becomes a terrace or abandoned floodplain. It is therefore important to be able to distinguish the active floodplain from abandoned terraces when identifying bankfull stage. Thinking in terms of stage of channel evolution will help in this process.

Indicators of Bankfull Stage

The following physical features that result from the erosion and deposition associated with the bankfull flow serve as indicators of the bankfull stage.

- Nearly flat top of developing point bars: as the channel migrates across the valley it builds the active floodplain in its wake through the development of point bars. The top of the point bar is the active floodplain.
- Flat depositional benches or lateral bars: On straighter sections of river will often exist as lateral bars. These bars may also represent the active floodplain.
- Location of change on the bank from steep to more gentle slope: On reaches of river that are not prone to active floodplain building, the break in bank slope often corresponds to the bankfull stage.

- Lower extent of persistent woody vegetation: Because of the fairly frequent occurrence of bankfull all but the most water tolerant tree species (alder and willow) will not typically grow within the bankfull channel.
- Erosion or scour features: On steeper gradient, naturally entrenched rivers the active floodplain may be intermittent in occurrence or altogether not present. In this case it becomes necessary to rely on erosional features along the banks as indicators of the flow stage that performs the most work. Because erosion can be caused by many processes such as ice scour and may not be related at all to the stage of the bankfull flow these features should be relied upon only when absolutely necessary.

The following photos show bankfull indicators that were used in development of the VT Regional Hydraulic Geometry Curves.

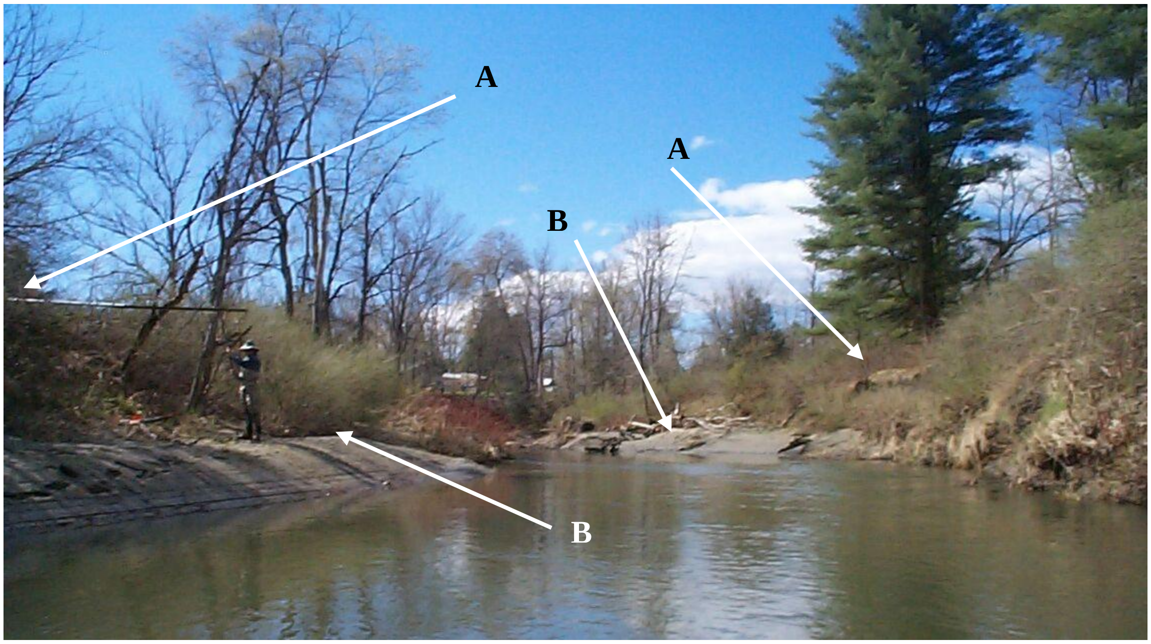

Figure 1 Embryonic active floodplain developing in incised channel. Stage IV of channel evolution.

a. Abandoned floodplain
b. Active floodplain indicating bankfull stage

Figure 2 Well developed lateral bar indicating bankfull stage.

Figure 3 Close up of Figure 2. Survey rod shows slope (nearly flat) of the lateral bar surface.

Figure 4 Lateral bar indicating bankfull stage. Note that the upslope flag is location of bankfull stage. At this location the slope of the bar surface becomes nearly flat. Also note the woody vegetation line at that point.

Figure 5 Removed view of Figure 4. Note that the most significant break in slope is disregarded for the location on the bank where the slope becomes flat and a change in vegetation occurs.

Figure 6 Bench feature indicating bankfull. Survey rod shows the slope of the bench surface.

Figure 7 Example of a well developed floodplain in a system characterized by boulder size boundary material.

Protocol for Identification of Bankfull

You should never rely upon one indicator of bankfull as definitive evidence of the bankfull stage. Any individual piece of evidence can be misleading (Leopold 1994). Observing as many bankfull indicators as can be found in the reach is the best procedure. Following the protocol below will help assure correct identification of the bankfull stage.

1. Walk the entire reach flagging indicators of bankfull stage. Avoid areas of bedrock, rip rap, bridge footings or other physical constraints. Remember that on incised channels the most evident flat valley surface may be an abandoned terrace. Rely on local knowledge and common sense as a guide in deciding whether it is realistic that a particular elevation is inundated nearly every year.
2. The elevation of each indicator above the current water surface should be consistent within 0.5 feet. If a particular indicator is not within this range it is probably not a good indicator of the bankfull stage.
3. Calculate the average height above water surface for the bankfull indicators identified. This value may be used to determine the bankfull stage at a location within the reach at which there are no strong bankfull indicators.
4. VT DEC has developed hydraulic geometry curves which plot bankfull channel dimensions on stable streams as a function of drainage area. Once the bankfull stage has been identified, quickly measure the bankfull width and compare to the VT DEC hydraulic geometry curves to help verify the correct bankfull elevation.

For further discussion on the identification of bankfull indicators and the processes that create these indicators see: Dunne and Leopold (1978); Leopold and Maddock (1953); Emmett (1975); Harrelson et.al. (1994); Rosgen (1996).

References

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